

Homework 1

due 9/5/06

1. Energy Scales:

- a) Find magnetic field at which $\mu_B H = E_F$ for a typical metal.
- b) Find magnetic field at which $\mu_B H = k_B T$.
- c) Find temperature at which $\mu_B H = k_B T$ for $H = 1$ Tesla.

2. Magnetic levitation of a diamagnetic sphere

- a) Suppose a uniform in an xy - plane magnetic field changes with height, z , as

$$H(z) = H_0 \frac{a^3}{z^3}$$

where H_0 and a are constants and $z > 0$.

A small perfectly diamagnetic ball of mass density ρ is placed in such field. Find the distance z_0 at which the ball will be stationary (levitating) above the ground. Estimate z_0 numerically for $H_0 = 1$ Tesla (remember we work in cgs!), $a = 1$ cm and $\rho = 7$ g/cm³.

- b) Speculate on the size dependence of the levitating ball.
- c) Using Maxwell equations and magnetic induction profiles throughout a ball provide reasoning why there can be no truly perfect diamagnet.